cured, since we have no test adequate to establish such a verdict. Whether or not the apparent cures are real and permanent, it is evident that we have a valuable agent at our disposal in the control of the disease.

ON THE POSSIBILITIES OF USING MOSQUITO TRAPS IN ANTIMALARIA WORK.

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It appears to the writer that the eradication or control of malaria in the United States is rapidly becoming, if it has not already become, essentially a rural problem, centering around the relatively isolated farmhouse. Here the operations of draining and oiling that are practicable and efficient in urban districts can not be applied on any adequate scale under present economic conditions. Screening is likewise subject to grave practical disadvantages as a wholesale measure, partly because the effective use of screens would necessitate as a prerequisite the rebuilding of a good proportion of the houses to be protected. On the other hand, if elimination of malaria be attempted through treatment of the human host, equal practical difficulties are encountered. To what, then, can we look for any hopeful line of attack on this problem?

One possibility suggests itself when one considers the fact that the focal point of the danger is the farmhouse itself. It seems safe to say that the malaria plasmodia are transmitted from man to mosquito and from mosquito to man mainly indoors or about the house. This means that, in general, the only dangerous mosquitoes are those in or near dwellings. Consequently, if some method could be devised for eradicating or materially reducing the number of these it ought to prove an effective agent in lessening malaria transmission.

Obviously the simplest manner of doing this would be by means of traps or poison, provided they were effective. In all probability both have been tried many times in the past, for the method is too simple and easy not to have received attention from tormented sufferers or others; but the fact remains that no practical exterminator has resulted. This may be because the habits of Anopheles are not such as to make them sufficiently susceptible to baits or traps, or it may be because the subject has not received adequate consideration. I venture to believe the latter, or at least to believe that the matter merits further attention and study, especially from the viewpoint of the biology of the mosquito.

With these features in mind a few preliminary observations and experiments were undertaken in 1918, but they were discontinued

early in 1919 and I have been unable to resume them since. Although they merely scratched the surface of the problem, they gave certain results that seem to be of sufficient interest to warrant publication in the hope that others may test their possibilities further.

The observations were concerned primarily with determining what things, if any, served to attract adult Anopheles ("things" being meant to include anything, animate or inanimate, that seemed practicable). Observations were not carried on very extensively for they soon led to experiments that absorbed attention up to the time the work was discontinued, and only the latter need be considered here. The experiments were confined to the question of traps and bait, rather than to poison, since the primary object at first was to ascertain what would attract the mosquitoes. The various fruitless experiments need not be reviewed, and attention will be confined here to one aspect of the work.

It has been observed in connection with other experiments that Anopheles are strongly attracted by pigs, and with this fact as a starting point experiments were undertaken in the hope that use could be made either of the pigs themselves or of some artificial substitute that would prove equally attractive. The experiments were relatively crude and not extensive, but the results are at least suggestive of further possibilities.

Without going into details, it may be stated briefly that traps of various sorts were constructed in which live pigs were kept. These were, essentially, small pig-pens. After various trials the type represented in the accompanying photographs was found to combine the essential features (for experimental purposes), namely, sufficient stability to prevent destruction by the pig, a satisfactory apparatus for facilitating the entrance but preventing the escape of the mosquitoes, and a practicable size and weight.[1]

The record of two of these traps may be outlined in detail. They were set up at the Coronet Phosphate Mines, near Plant City, Fla. Owing to the enlightened management of the company operating these mines, there was little or no malaria there, but the locality had many advantages for experimental work. Not the least of these was owing to the hearty cooperation of Mr. Greene, the manager of the plant, to whom I am deeply indebted for the many facilities placed at my disposal and for the actual construction of much of the apparatus used.

The source of Anopheles was a cypress swamp near the plant. This was not a prolific breeding place, but it served to supply Ano-

[1] These traps were about 3 feet wide, 3 feet high, and 5 feet long, with no floor, a small door in one end and an entrance way for the mosquitoes along both sides and the rear. The latter was made of screen, the width being about 8 inches at the outside and tapering to a slit about 1 inch wide through which the mosquitoes entered the cage.

pheles in fair numbers to the dwellings and outbuildings around the plant. Before the traps were installed it was an easy matter to catch from four or five to a dozen or more Anopheles in practically any privy near the swamp. The traps were placed somewhat less than a quarter of a mile apart—one near the swamp, the other away from it. The weather was for the most part warm, so that the mosquitoes were usually flying about and biting freely, although it was the winter season, when they were least numerous.[2]

The results are indicated by the following extracts from my notebook. Trap No. 1 was an old and inferior type of trap, located near the swamp; No. 2 was the type represented in the accompanying photographs; and No. 3 was the same type, used to replace No. 1. After each count the mosquitoes were killed or removed from the traps.

January 25, 1919. Traps exposed five days; weather mild.
Nos. 1 and 2 combined: 40 Anopheles (both crucians and quadrimaculatus).[3]
January 29. Weather mild.
No. 1: 32 Anopheles (both species).[4]
No. 2: 13 Anopheles (both species).
45 (total)
February 1. Weather mild; nights of January 29 and 30 cool.
No. 1: 24 Anopheles (both species).
No. 2: 17 Anopheles (both species).
41 (total)
Examination of four privies near the traps revealed a total of only five Anopheles.
February 7. After five days of almost steady rain.
No. 1: 17 Anopheles (both species).
No. 2: 30 Anopheles (both species).
47 (total)
Examination of four privies and underneath one house (the best places near the traps) revealed only two Anopheles.
February 11. After three days of cold weather.
No. 1: Pigs had escaped; no Anopheles.
No. 2: 3 Anopheles.
February 14. After heavy rain, weather warm.
No. 1: No pigs.
No. 2: 8 Anopheles, 2 Culex.
Nearby privy, 3 Anopheles.
February 25. (After absence to Wilmington conference). Weather warm. Mr. Le Prince present.
No. 3: 24 Anopheles (both species).
No. 2: 52 Anopheles (both species).
76 (total)
Two privies near by contained only one Anopheles.

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[2] In this region (30 miles east of Tampa) Anopheles are active and apparently bite freely at all seasons.
[3] No Anopheles punctipennis were found in this region and they probably do not occur here.
[4] The exact proportions of the two species was not determined, for it was not always possible to identify the species before the specimen was killed. Apparently the attraction of the traps was equally effective on both species.

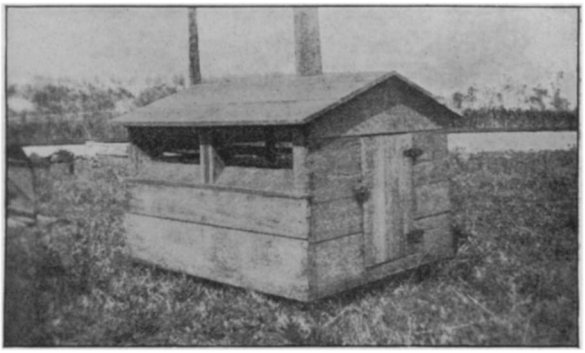

Fig. 1.—Front view of pigpen mosquito trap. When in use, the sides of the trap were banked with dirt to close the openings at the bottom.

Fig. 2.—Rear view of the same type of trap, showing the entrance-way for the mosquitoes along the side and end.

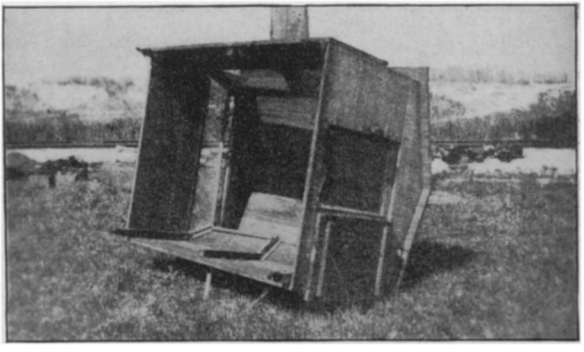

Fig. 3.—Trap turned on its side to show the interior. Note the trough-like entrance-way with the narrow opening through which the mosquitoes enter.

Superficial examination of the building around the plant during the course of these experiments indicated pretty clearly that Anopheles were becoming more and more scarce in them, and it seems safe to say that while the traps were both in operation most of the Anopheles in the immediate neighborhood at any one time were in the traps.

Meager as these data are, they serve to demonstrate two things: First, that Anopheles react sufficiently to some stimuli to be enticed into traps, and, second, that under the conditions of the present experiment the use of traps served to keep near-by buildings practically free from Anopheles. One dwelling was included in this area, and it seemed to be as free from Anopheles as the privies and other buildings.

Numerous defects are evident in this particular type of trap or any trap involving the use of live animals that would have to be cared for,[5] and it is not suggested that such a trap provides any solution of the problem. On the other hand, if, for instance, a chemical substance could be substituted for the pig, the way would seem to be opened for the perfection of an effective trap. Once the practicable attractive agent were discovered, ingenuity would soon evolve an inexpensive and convenient (as well as "fool-proof") type of trap or else an effective poison.

Numerous attempts were made to secure such an attracting substance. A great many chemicals and compounds were tried, including the fatty acids, caproic, butyric, and propionic, but much of the early work was done with traps that probably would not have been suitable even if the bait had proved attractive. This fact, together with the brevity of the experiments, makes it seem best not to prejudice the case against any of the things used by enumerating them.

The problem, I believe, merits careful attention from the biologist and biochemist, and I commend it to any who have the opportunity to conduct such an investigation. It does not seem ultravisionary to imagine that careful study of the sensory reactions of Anopheles, combined with chemical analyses and experiments, would suffice to detect the particular stimuli to which Anopheles respond, and to synthesize substances that would produce these stimuli satisfactorily for the purpose. In making this statement I am fully aware of the idiosyncrasies of Anopheles, the differences between the habits of the respective species, and the influence of different environments on anopheline reactions, all of which present difficulties—but not, I believe, insuperable ones.

[5] Lacking any better method, however, it might be suggested that a type of pigpen trap suitable for use in special cases could be constructed with a swinging door, hinged at the top, through which the pigs could pass in and out at will. The Anopheles, after having fed, seem content to remain in the traps and apparently make little effort to escape through cracks, etc., especially if these are down near the ground.